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American Association State
Highway and Transportation Officials Standard
AASHTO No: T72
Method 304—Federal Test
Method Standard No. 791b
Replaces Method 4285 of Federal Test
Method Standard No. 141A

Standard Test Method for Saybolt Viscosity¹

This standard is issued under the fixed designation ~~D88~~; **D88/D88M**; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

^{ε1} NOTE—Units information was editorially corrected in May 2019.

1. Scope

1.1 This test method covers the empirical procedures for determining the Saybolt Universal or Saybolt Furol viscosities of petroleum products at specified temperatures between 21 and 99°C (70 and 210°F). A special procedure for waxy products is indicated.

NOTE 1—Test Methods **D445** and ~~D2170~~**D2170/D2170M** are preferred for the determination of kinematic viscosity. They require smaller samples and less time, and provide greater accuracy. Kinematic viscosities may be converted to Saybolt viscosities by use of the tables in Practice **D2161**. It is recommended that viscosity indexes be calculated from kinematic rather than Saybolt viscosities.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as the standard. The values given in parentheses are for information only; each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*²

2. Referenced Documents

2.1 ASTM Standards:²

- [D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester](#)
- [D117 Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids](#)
- ~~D140~~[D140/D140M Practice for Sampling Asphalt Materials](#)
- [D244 Test Methods and Practices for Emulsified Asphalts](#)
- [D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids \(and Calculation of Dynamic Viscosity\)](#)
- [D2161 Practice for Conversion of Kinematic Viscosity to Saybolt Universal Viscosity or to Saybolt Furol Viscosity](#)
- ~~D2170~~[D2170/D2170M Test Method for Kinematic Viscosity of Asphalts](#)
- [D4057 Practice for Manual Sampling of Petroleum and Petroleum Products](#)
- [D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products](#)
- [E1 Specification for ASTM Liquid-in-Glass Thermometers](#)
- [E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves](#)
- ~~E102~~[E102/E102M Test Method for Saybolt Furol Viscosity of Bituminous Materials at High Temperatures](#)

¹ This test method is under the jurisdiction of ASTM Committee **D08** on Roofing and Waterproofing and is the direct responsibility of Subcommittee **D08.05** on Solvent-Bearing Bituminous Compounds for Roofing and Waterproofing.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 Definitions:

3.1.1 *Furol*—an acronym of “Fuel and road oils.”

3.1.2 *Saybolt Furol viscosity*—the corrected efflux time in seconds of 60 mL of sample flowing through a calibrated Furol orifice under specified conditions. The viscosity value is reported in Saybolt Furol seconds, abbreviated SFS, at a specified temperature.

3.1.3 *Saybolt Universal viscosity*—the corrected efflux time in seconds of 60 mL of sample flowing through a calibrated Universal orifice under specified conditions. The viscosity value is reported in Saybolt Universal seconds, abbreviated SUS, at a specified temperature.

4. Summary of Test Method

4.1 The efflux time in seconds of 60 mL of sample, flowing through a calibrated orifice, is measured under carefully controlled conditions. This time is corrected by an orifice factor and reported as the viscosity of the sample at that temperature.

5. Significance and Use

5.1 This test method is useful in characterizing certain petroleum products, as one element in establishing uniformity of shipments and sources of supply.

5.2 See Guide [D117](#) for applicability to mineral oils used as electrical insulating oils.

5.3 The Saybolt Furol viscosity is approximately one tenth the Saybolt Universal viscosity, and is recommended for characterization of petroleum products such as fuel oils and other residual materials having Saybolt Universal viscosities greater than 1000 s.

5.4 Determination of the Saybolt Furol viscosity of bituminous materials at higher temperatures is covered by Test Method [E102/E102M](#).

6. Apparatus

6.1 *Saybolt Viscometer and Bath*, as shown in [Fig. 1](#) and described in [Annex A1](#).

6.2 *Withdrawal Tube*, as shown in [Fig. 2](#).

6.3 *Thermometer Support*, as shown in [Fig. 3](#).

6.4 *Saybolt Viscosity Thermometers*, as listed in [Table 1](#), for reading the temperature of the sample. Each thermometer shall conform to the requirements listed in Specification [E1](#) for that ASTM Thermometer Number.

6.5 *Bath Thermometers*—Saybolt Viscosity thermometers, or any other temperature-indicating means of equivalent accuracy.

6.6 *Filter Funnel*, as shown in [Fig. 4](#), equipped with interchangeable 150- μm (No. 100) [[No. 100](#)] and 75- μm (No. 200) [[No. 200](#)] wire-cloth inserts meeting the requirements of Specification [E11](#) with respect to the wire cloth.

6.7 *Receiving Flask*, as shown in [Fig. 5](#).

6.8 *Timer*; graduated in tenths of a second, and accurate to within 0.1 % when tested over a 60-min interval. Electric timers are acceptable if operated on a controlled frequency circuit.

7. Sampling

7.1 Sample the material in accordance with Practices [D140/D140M](#), [D4057](#), or [D4177](#), as appropriate.

8. Preparation of Apparatus

8.1 Use a Universal orifice or tip for lubricants and distillates with efflux times greater than 32 s to give the desired accuracy. Liquids with efflux times greater than 1000 s are not conveniently tested with this orifice.

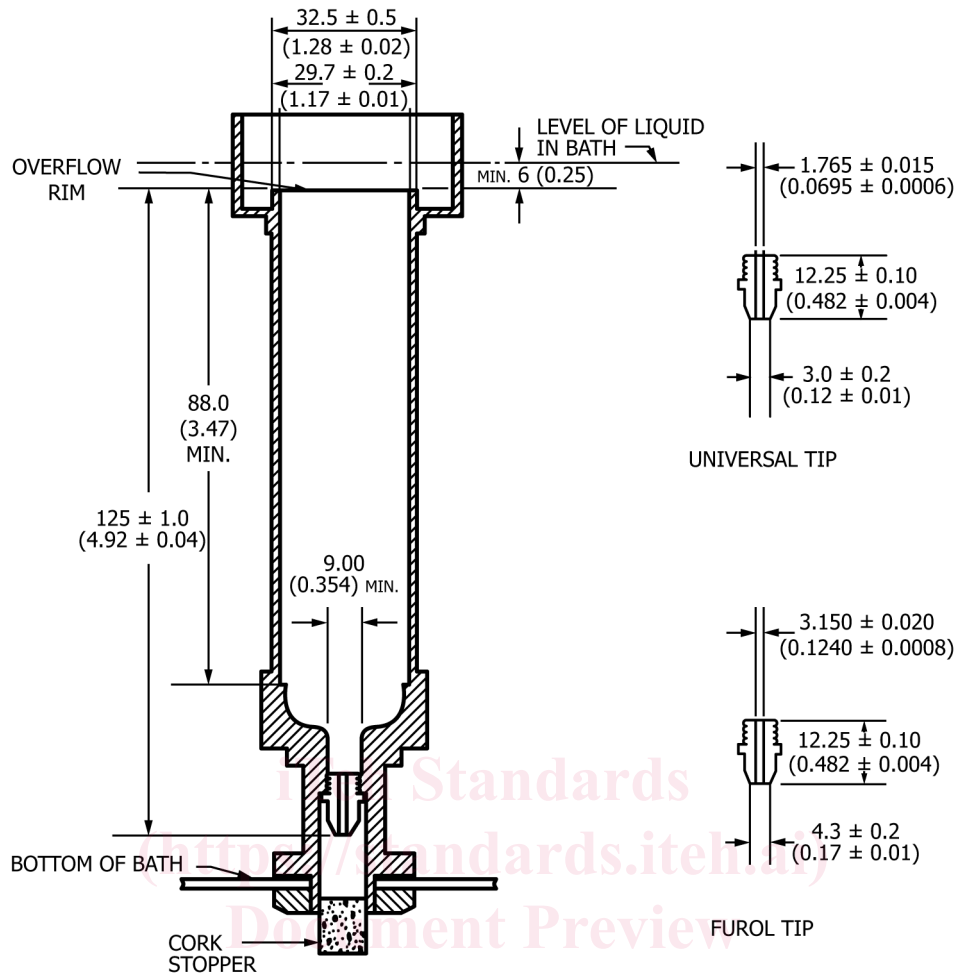
8.2 Use a Furol orifice or tip for residual materials with efflux times greater than 25 s to give the desired accuracy. See also [5.3](#).

8.3 Clean the viscometer thoroughly with an appropriate solvent of low toxicity; then remove all solvent from the viscometer and its gallery. Clean the receiving flask in the same manner.

NOTE 2—The plunger commonly supplied with the viscometer should never be used for cleaning; its use might damage the overflow rim and walls of the viscometer.

8.4 Set up the viscometer and bath in an area where they will not be exposed to drafts or rapid changes in air temperature, and dust or vapors that might contaminate a sample.

8.5 Place the receiving flask ([Fig. 5](#)) beneath the viscometer so that the graduation mark on the flask is from 100 to 130 mm ([4 to 5 in.](#)) below the bottom of the viscometer tube, and so that the stream of oil will just strike the neck of the flask.



NOTE 1—All dimensions are in millimetres (inches).

FIG. 1 Saybolt Viscometer with Universal and Furol Orifice

<https://standards.iteh.ai/catalog/standards/astm/d65f07cc-f290-4d6f-9230-09a450286142/astm-d88-d88m-072019e1>

8.6 Fill the bath to at least 6 mm ($\frac{1}{4}$ in.) above the overflow rim of the viscometer with an appropriate bath medium selected from Table 2.

8.7 Provide adequate stirring and thermal control for the bath so that the temperature of a test sample in the viscometer will not vary more than $\pm 0.03^{\circ}\text{C}$ ($\pm 0.05^{\circ}\text{F}$) [$\pm 0.05^{\circ}\text{F}$] after reaching the selected test temperature.

8.8 Do not make viscosity measurements at temperatures below the dew point of the room's atmosphere.

8.9 For calibration and referee tests, keep the room temperature between 20 and 30°C (68 [68 and 86°F]; 86°F), and record the actual temperature. However room temperatures up to 38°C (100°F) [100°F] will not introduce errors in excess of 1%.

9. Calibration and Standardization

9.1 Calibrate the Saybolt Universal viscometer at periodic intervals by measuring the efflux time at 37.8°C (100°F) [100°F] of an appropriate viscosity oil standard, following the procedure given in Section 10. See Annex A2 for viscosity oil standards available.

9.2 The efflux time of the viscosity oil standard shall equal the certified Saybolt viscosity value. If the efflux time differs from the certified value by more than 0.2 %, calculate a correction factor, F , for the viscometer as follows:

$$F = V/t \quad (1)$$

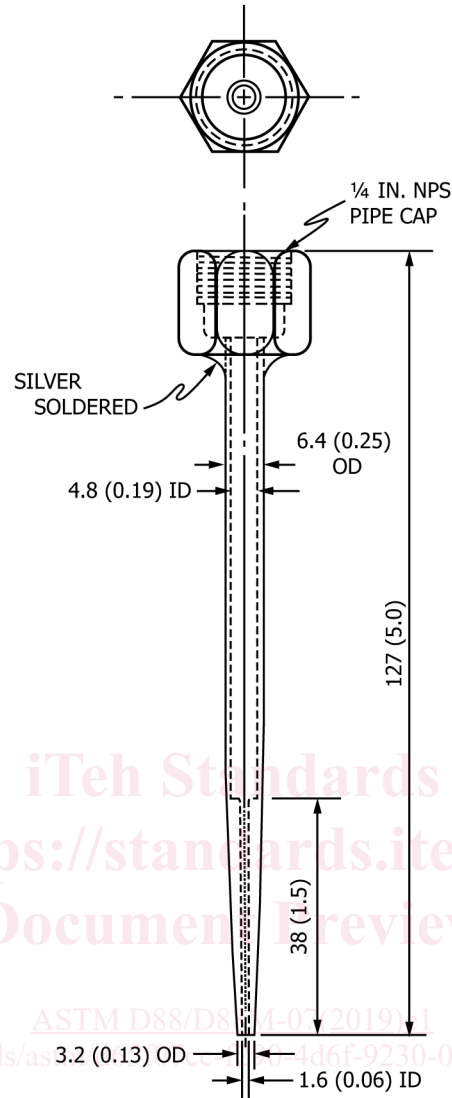
where:

V = certified Saybolt viscosity of the standard, and

t = measured efflux time at 37.8°C (100°F), s.

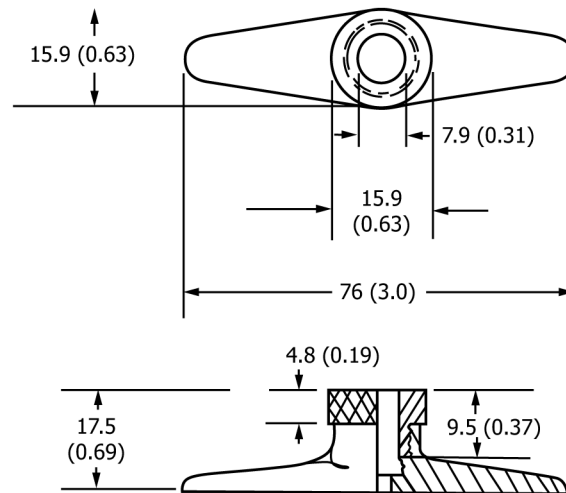
t = measured efflux time at 37.8°C [100°F], s.

NOTE 3—If the calibration is based on a viscosity oil standard having an efflux time between 200 and 600 s, the correction factor applies to all viscosity levels at all temperatures.



NOTE 1—All dimensions are in millimetres (inches).

FIG. 2 Withdrawal Tube for Use with Saybolt Viscometer



NOTE 1—All dimensions are in millimetres (inches).

FIG. 3 Thermometer Support